

Air Quality Monitoring:

Edmonton Fire Department Training Site

Aug 27 and 31, 2007

Final Report

Overview

Alberta Environment was requested to monitor the air quality in the vicinity of the Edmonton Fire Department's training facility during a fire fighting exercise. A number of gases and particulate matter were monitored at various locations. Two mobile units and other supporting instrumentations were used to conduct monitoring. Of particular interest to the study were the concentrations of particulate matter, polycyclic aromatic hydrocarbons (PAHs) and formaldehyde. Particulate matter and PAHs were found to be elevated closer to the burn site. There was also evidence that particulate matter emitted at the training facility affected a business area located 0.5 km downwind.

A maximum one-hour average $PM_{2.5}$ of $296 \mu\text{g}/\text{m}^3$ was measured at the training facility. Concentrations at this location indicate levels of exposure to fire fighters at the site. Half a kilometre downwind, the maximum one-hour concentration was lower at $41 \mu\text{g}/\text{m}^3$. Although lower than that measured at the training facility, this concentration is notably higher than the one-hour average concentration measured at air quality monitoring stations throughout the city. One-hour average concentration $PM_{2.5}$ at the three air quality monitoring stations in Edmonton ranged from $1\text{--}14 \mu\text{g}/\text{m}^3$. Elevated PAHs was measured near the burn site, where a one-hour maximum of $17 \text{ ng}/\text{m}^3$ was measured. Downwind of the burn site concentrations were low and close to instrument detection limit. PAHs concentrations were not measured within a smoke plume, where concentration may have been higher. Formaldehyde concentration did not exceed Alberta's ambient air quality objective of 0.053 ppm. The one-hour average formaldehyde concentrations for this study were found to be below detection limit (0.01 ppm).

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particulate matter concentration in three size ranges: particles less than 10 micrometer (μm) in aerodynamic diameter (PM_{10}), particles less than 2.5 μm in aerodynamic diameter ($\text{PM}_{2.5}$) and particles less than 1 μm in aerodynamic diameter (PM_1). The AMU was used to monitor very close to and directly downwind from the burn site, while the MAML was used to monitor for any billowing effect of smoke from the site.

To investigate formaldehyde concentration, one-hour integrated samples were collected using *Xposure Aldehyde Samplers*®. The sampler consists of a sorbent cartridge, through which a constant flow of air is pulled using a pump. As air passes through the sampler, formaldehyde will sorb onto the inside surface of these sorbent cartridge. At the end of each sampling period the cartridge is sealed and sent to the laboratory where extracts from the samplers were analyzed for formaldehyde. This sampling method has a detection limit of about 0.01 ppm; the one-hour Alberta's Ambient Air Quality Objective (AAAQO) for formaldehyde is 0.053 ppm. This method of sampling was used at **Sites 4-7** (Figure 1).

In addition to the integrated samples, the *MIRAN SapphIRe*®, here after referred to as the SapphIRe, was used to investigate concentrations in the vicinity of the burn site (**Site 4**). This instrument uses infrared spectroscopy to measure gases with a sub-ppm detection limit. Two such instruments were used. One SapphIRe was setup to measure formaldehyde. The second SapphIRe was setup to test for the presence of a number of compounds². In this setup, the instrument has the ability to identify compounds by matching compounds within its library. The SapphIRe can detect concentrations in as short a sample interval as one-minute. These one-minute concentrations are used to qualify the presence³ of specific gases, including formaldehyde, during the practice burns.

The map in Figures 1a and b illustrates the sampling locations. There were three general categories of sample sites: on-site, fence line and downwind sites. On the burn site, particulate matter (**Site 1f**) and formaldehyde (**Site 4**) were monitored. The MAML monitored at the gate of the burn site (**Site 1**). Downwind monitoring was conducted at a near by business area along 105 avenue between 184 and 186 street (**Site 2, 2f, 3 and 5-7**).

² See Table A7 in Appendix A

³ Above the detection limit of the instrument

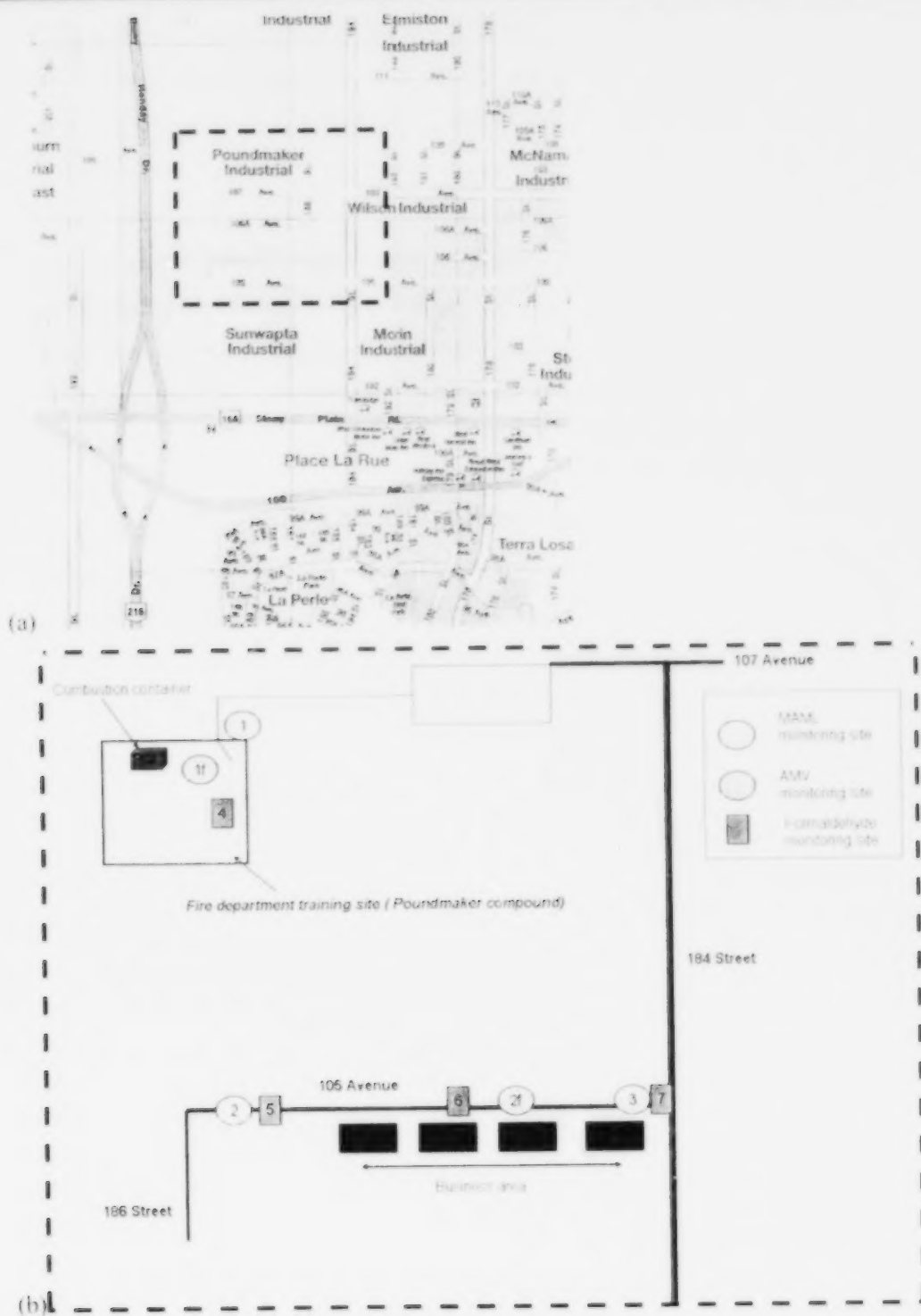


Figure 1: (A) map of monitoring area. The area marked by dash lines is expanded in the diagram shown in (B)

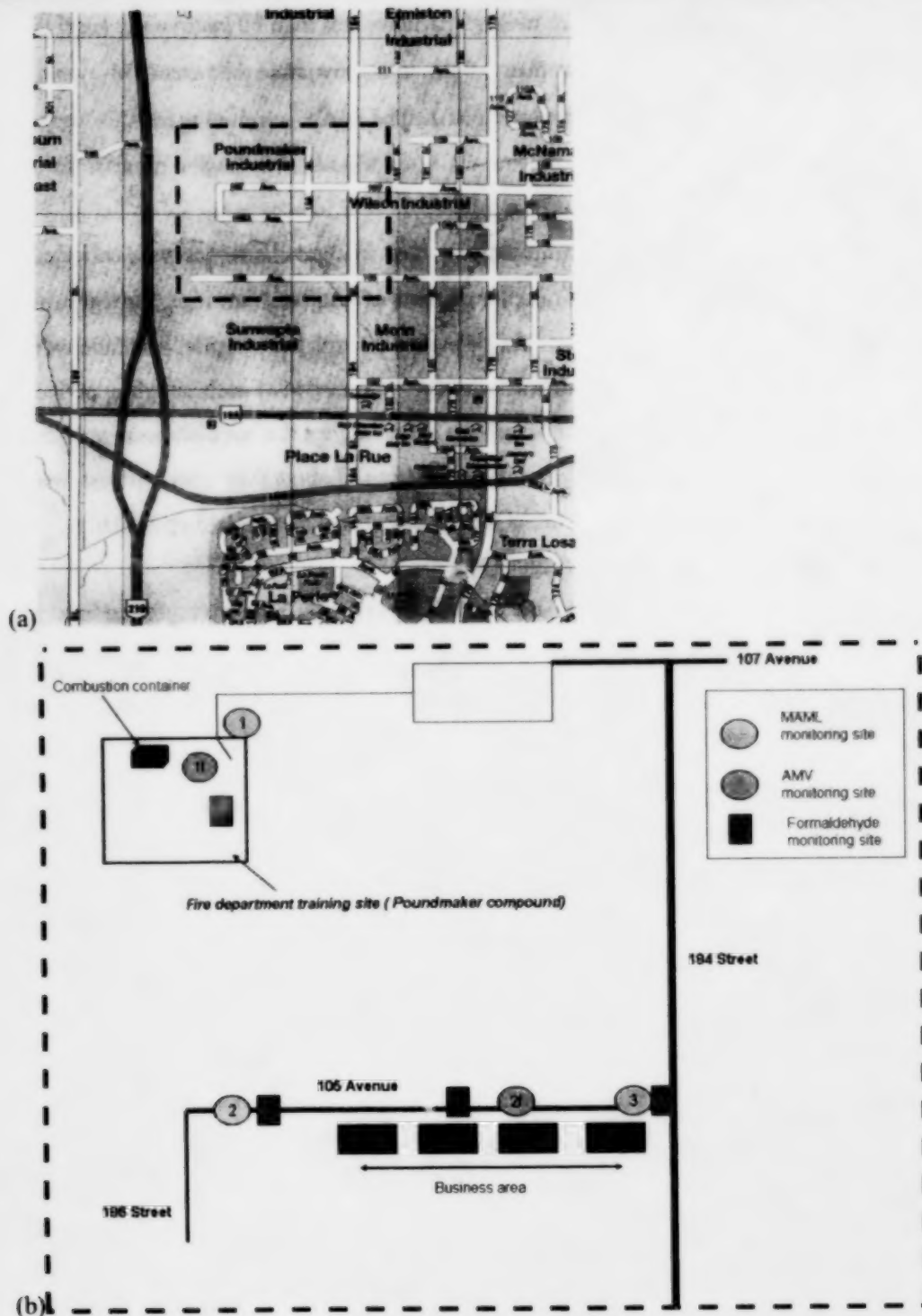


Figure 1: (A) map of monitoring area. The area marked by dash lines is expanded in the diagram shown in (B)

3. Results and Discussion

The following sections will discuss compounds most relevant to the current study, namely particulate matter, polycyclic aromatic hydrocarbons, oxides of nitrogen, carbon monoxide and formaldehyde. One-hour average concentrations are compared to air quality objectives where appropriate. In addition, one-minute concentrations are presented to illustrate the maximum concentration measured during the hour. A key for interpreting the figures presenting one-hour median and maximum concentrations is found in Figure 2. The concentrations for all the compounds monitored are provided in Appendix A (Table A1-A5). Comparison concentrations measured at Edmonton air quality monitoring stations are presented in Table A6.

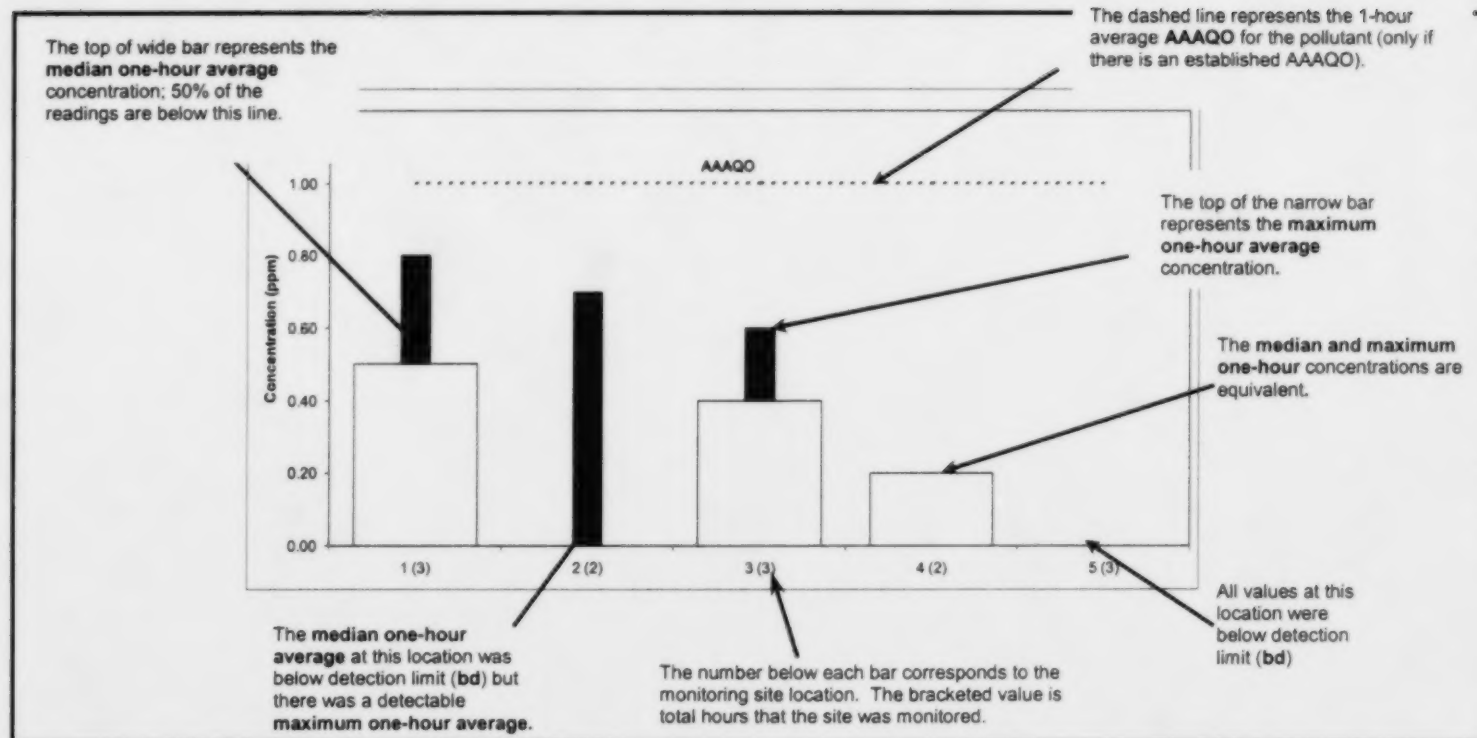


Figure 2: A key for interpreting the figures presenting median and maximum one-hour averages.

3.1. Particulate Matter (PM) and Polycyclic Aromatic Hydrocarbons (PAHs)

Particulate matter (PM_{10} , $PM_{2.5}$ and PM_1) were monitored at and close to the burn site (**Site 1** and **1f**) as well as downwind from the burn site (**Site 2, 3** and **2f**). PM_{10} are the fraction of particles that can be inhaled into the mouth and nose. $PM_{2.5}$ and PM_1 are small enough to be respired into the lungs. Wood combustion produces large amounts of particulate matter. For example, soft wood species can produce 2-4 grams (g) of $PM_{2.5}$ for every kilogram (kg) of wood burnt⁴. Although particle board rather than wood is burnt during these fire fighting exercises, particulate matter is expected to be emitted.

Figures 3-5 illustrate the median and maximum one-hour average particulate matter concentrations measured at the various sites. The highest concentrations were measured at the burn site (**Site 1f**). This site was 30 m from the burn container and concentrations measured at **Site 1f** indicate concentrations fire fighters on-site are exposed to. The median one-hour average PM_{10} , $PM_{2.5}$ and PM_1 concentrations at **Site 1f** were 96, 60 and $29 \mu\text{g}/\text{m}^3$, respectively. For comparison, particulate concentration at the three Edmonton air quality monitoring stations (for August 31 08:00-16:00) are illustrated in Figure 4 and 5. The median one-hour average $PM_{2.5}$ concentrations at Edmonton Downtown, East and South air quality monitoring stations were 3, 2 and $7 \mu\text{g}/\text{m}^3$, respectively. These concentrations are many times lower than $PM_{2.5}$ concentrations measured at **Site 1f**. The level of smoke and particulate matter at **Site 1f** varied; for example, the maximum one-hour $PM_{2.5}$ concentration of $296 \mu\text{g}/\text{m}^3$ was a factor of five higher than the median concentration. Particulate matter concentrations during periods of heavy smoke (Aug 31st 09:00 and 14:30) exceeded the instrument's maximum detection limit ($1 \text{ g}/\text{m}^3$ for $PM_{2.5}$). Thus due to gaps in the data, the maximum one-hour concentration calculated was likely higher than the concentration reported.

Smoke from the burn container can also affect a business area located about 0.5 km southeast of the burn site (Figure 1: **Sites 2, 2f** and **3**). Two of the three sample hours at **Site 2f** were influenced by smoke. Recall that **Sites 1f** and **2f** were within the burn site's smoke plume (Section 2). A large fraction of the particles at **Site 2f** were smaller than $2.5 \mu\text{m}$ in diameter ($PM_{2.5}$). The median one-hour average $PM_{2.5}$ concentration was $31 \mu\text{g}/\text{m}^3$. The one-hour average PM_{10} and PM_1 concentrations during the same sample hour were 37 and $15 \mu\text{g}/\text{m}^3$. At

this downwind site concentrations were notably lower than measured at **Site 1f**. This being said, $PM_{2.5}$ concentrations at **Site 2f** were still higher than concentrations measured at the three Edmonton air quality monitoring stations. In fact, for periods when smoke was observed at **Site 2f**, one-minute average $PM_{2.5}$ concentrations greater than $80 \mu\text{g}/\text{m}^3$ were frequently observed (Figure 6).

Particulate matter concentrations measured at the edge of the plume (when located downwind) or out of the plume's path were lower. One-hour average $PM_{2.5}$ concentrations at **Sites 1-3** ranged from 6 to $10 \mu\text{g}/\text{m}^3$, PM_{10} concentrations ranged from 13 to $36 \mu\text{g}/\text{m}^3$ and concentrations for the PM_1 fraction ranged from 3 to $6 \mu\text{g}/\text{m}^3$. As is illustrated in Figures 3 and 4, one-hour average particulate matter concentrations at these sites were comparable to concentrations measured at the Edmonton south station.

The MAML is also equipped to monitor particulate bound polycyclic aromatic hydrocarbons (PAHs). PAHs typically occur in complex mixtures. They form during incomplete combustion and thus are found in wood smoke and vehicle exhaust. Much like PM_{10} , $PM_{2.5}$ and PM_1 , PAHs concentrations are expected to increase when a sample is influenced by smoke from the practice fires.

PAHs concentration was monitored by an instrument on board the MAML at **Sites 1-3**. *One-minute* average PAHs concentrations greater than $40 \text{ ng}/\text{m}^3$, and as high as $457 \text{ ng}/\text{m}^3$ (Table A2) were measured. These elevated concentrations coincided with smoke from the burn site and were observed intermittently. One-hour average concentrations were notably lower. Median one-hour average concentration of $11 \text{ ng}/\text{m}^3$ was measured closer to the burn site (**Site 1**). Near the business area downwind of the burn site, the median one-hour concentration was lower at $3 \text{ ng}/\text{m}^3$ (**Sites 2 and 3**). Background PAHs concentrations measured during other air quality surveys typically are below the detection limit ($3 \text{ ng}/\text{m}^3$) of the instrument on board the MAML. On the other hand, one-hour average concentration as high as $154 \text{ ng}/\text{m}^3$ have been measured at a monitoring site⁵ heavily influenced by traffic. As implied by the particulate matter concentration comparison, samples collected by the MAML (**Site 1, 2 and 3**) were not as heavily impacted by smoke as those sampled by the AMU. PAHs concentrations within the smoke

⁴ Chemical Characterization of Fine Particulate Emissions from Fireplace Combustion of Woods Grown in the Southern United States. *Environmental Science and Technology*, 2002, 36, 1442-1451.

⁵ Site 4 in the MAML survey *Neighborhood of Calder Edmonton*. This site was less than 0.5 km north of the Yellowhead highway

plume could have been higher than measured by the MAML. The AMU, which monitored in the smoke plume, is not equipped to measure PAHs.

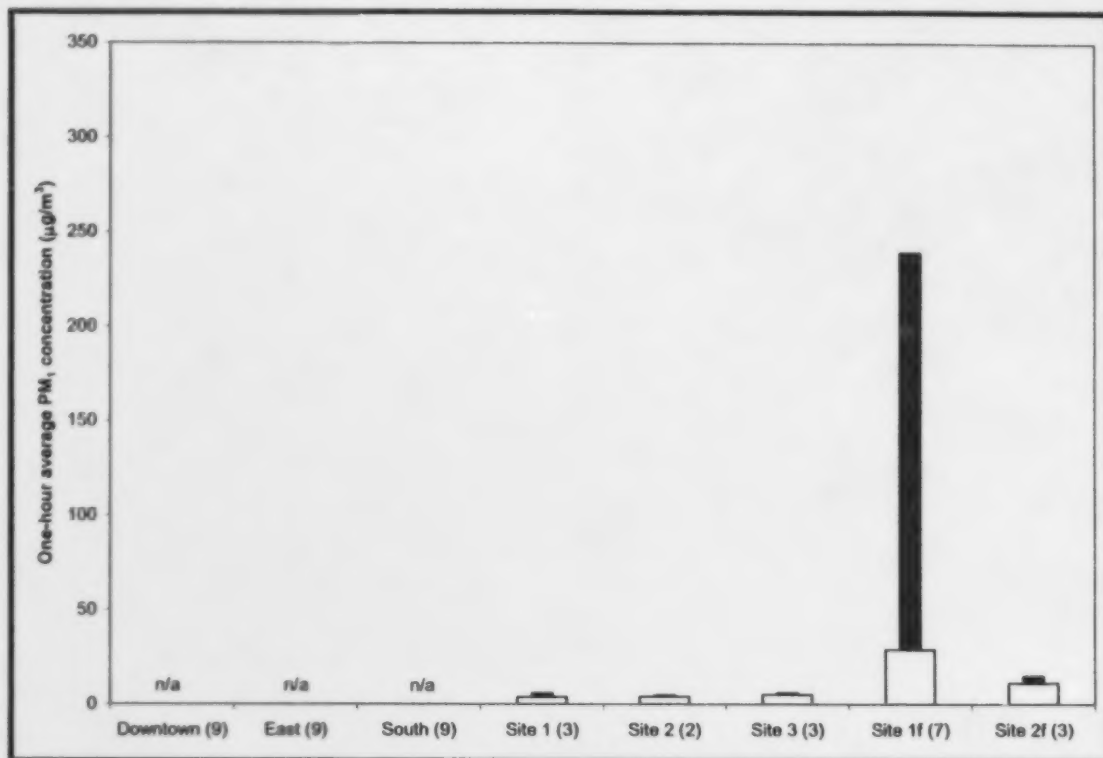


Figure 3: Median and maximum one-hour average concentrations for PM₁. PM₁ is not monitored at the three Edmonton air quality monitoring stations (Downtown, East and South). A key for interpreting this figure is presented in Figure 2.

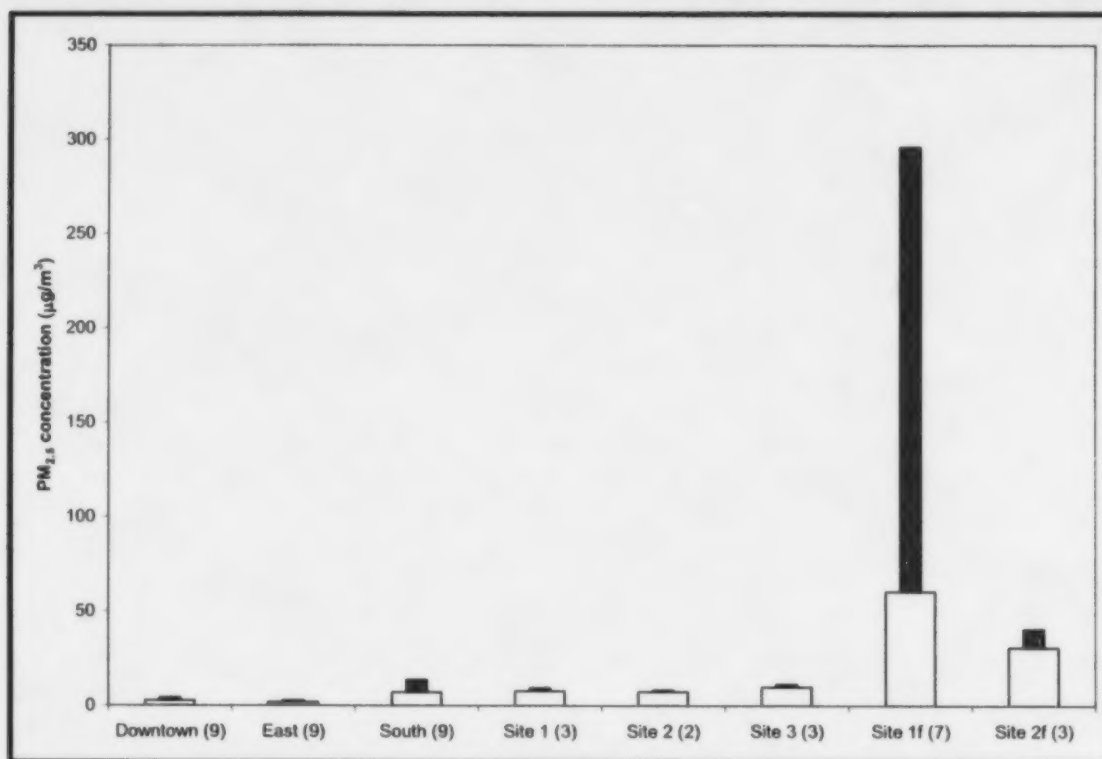


Figure 4: Median and maximum one-hour average concentrations for $PM_{2.5}$. Downtown, East and South indicate concentration at the three Edmonton air quality monitoring stations. A key for interpreting this figure is presented in Figure 2.

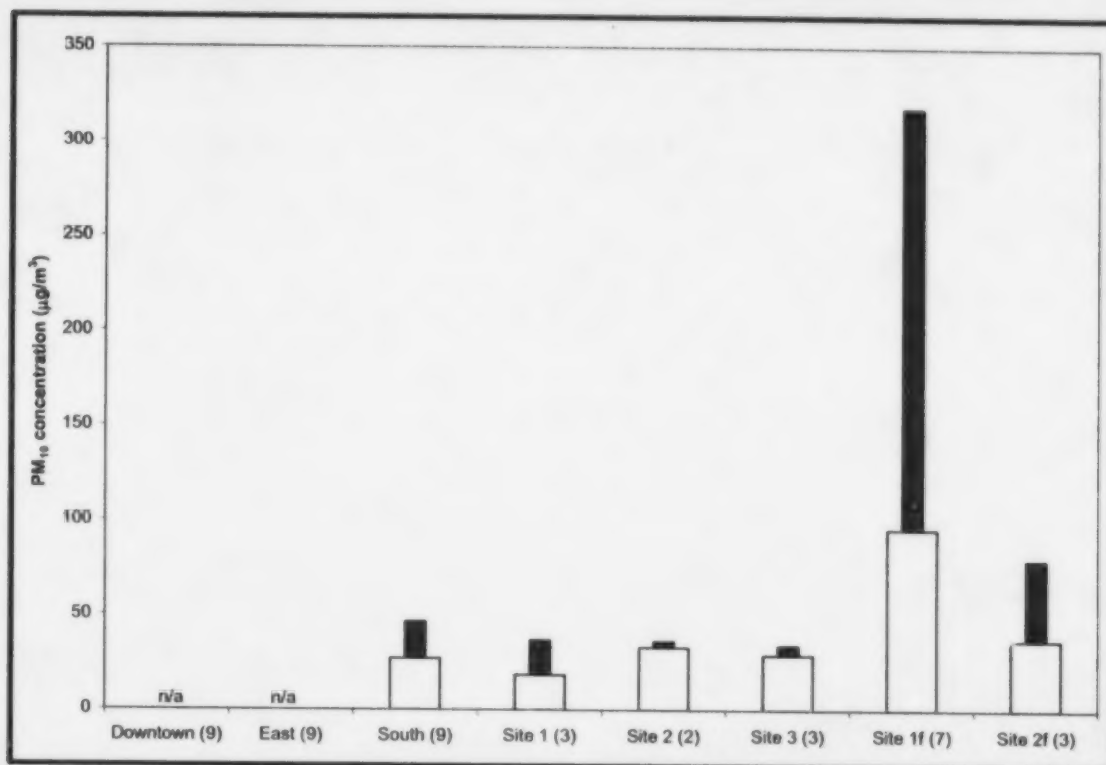


Figure 5: Median and maximum one-hour average concentration for PM₁₀. PM₁₀ is not monitored at Edmonton Downtown and East monitoring stations. A key for interpreting this figure is presented in Figure 2.

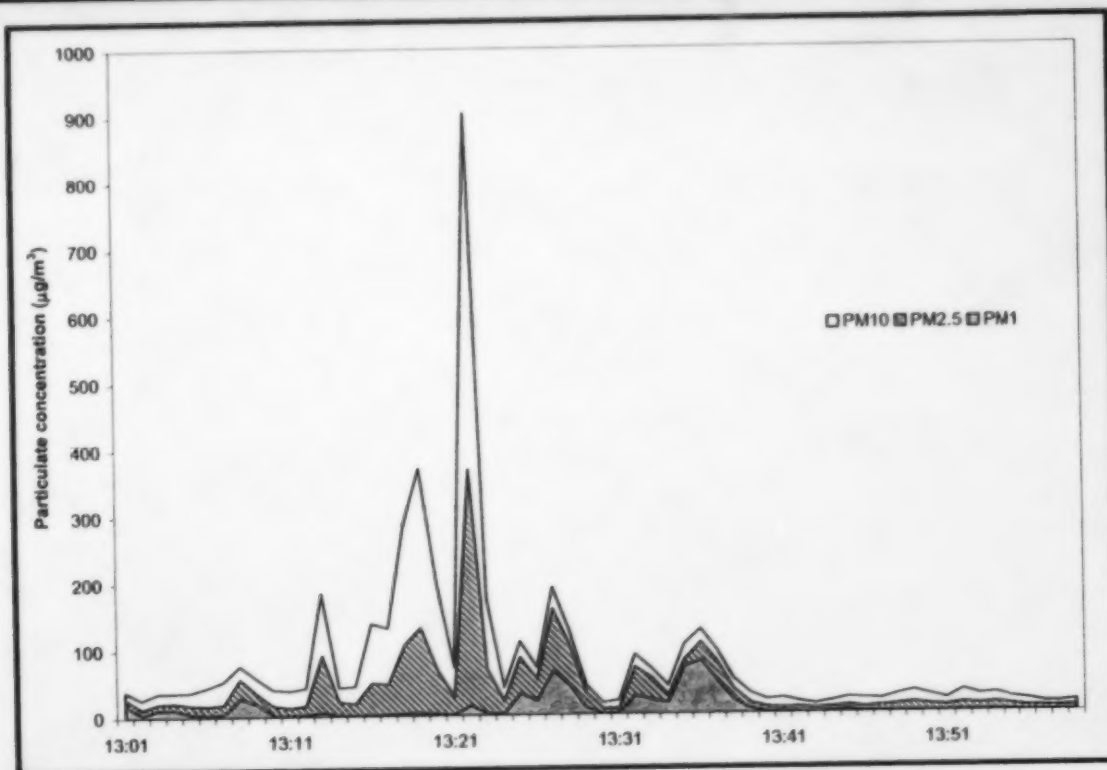


Figure 6: One-minute average concentrations as measured at Site 2f about 0.5 km downwind of the burn site. Smoke was noted at the site between 13:15 to 13:30, on August 31.

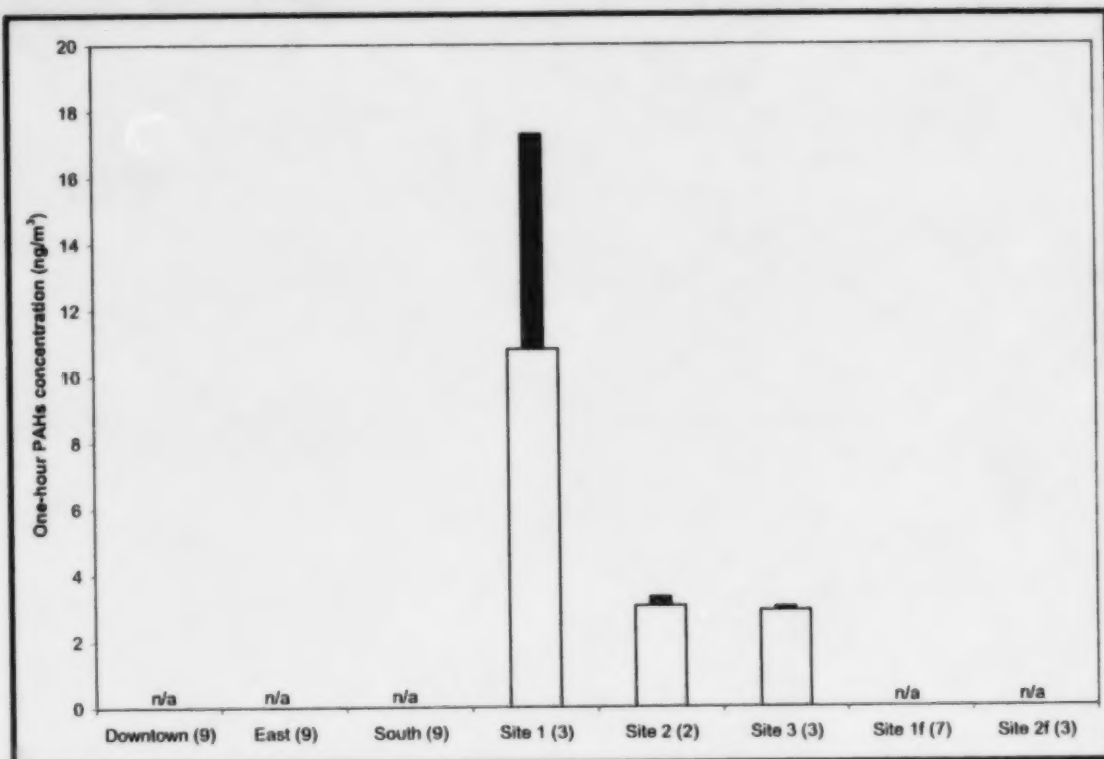


Figure 7: Median and maximum one-hour concentration for PAHs. PAHs are not monitored at the Edmonton air quality monitoring stations. The fire department's AMU is not equipped to monitor PAHs. Thus PAHs were not monitored at Site 1f and 2f. A key for interpreting this figure is presented in Figure 2.

3.2. Carbon Monoxide (CO)

Incomplete combustion produces carbon monoxide (CO). In urban centres, motor vehicles are the primary source of CO. Combustion processes such as the practice fires during this study can also emit CO. Alberta has a one-hour air quality objective of 13 ppm. The one-hour average concentrations at **Sites 1-3** ranged from 0.1- 0.3 ppm and were at most 2% of the AAAQO. In fact concentrations measured at these sites were comparable to concentration at the three Edmonton air quality monitoring stations (Figure 8). The maximum one-hour average CO concentration at Edmonton Downtown for example was 0.4 ppm.

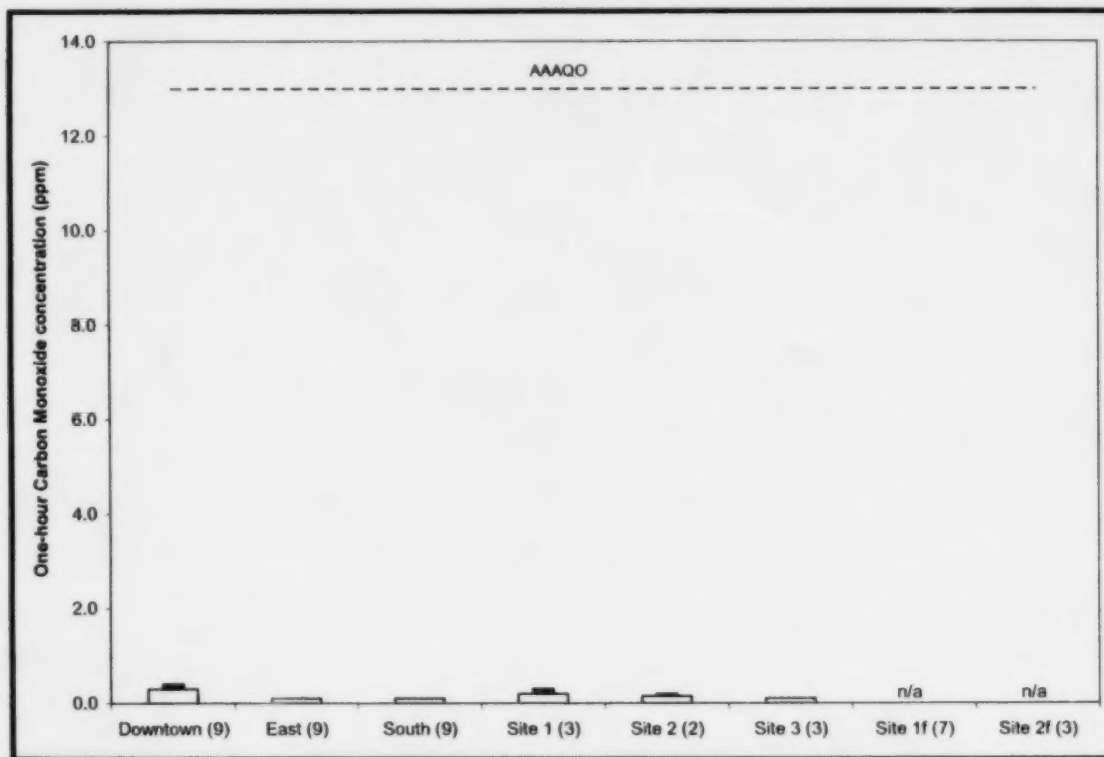


Figure 8: Median and maximum one-hour average concentrations for CO. Downtown, East and South indicate the results from the three Edmonton air quality monitoring stations. The AMU is not equipped to monitor carbon monoxide (Sites 1f and 2f). A key for interpreting this figure is presented in Figure 2.

3.3. Oxides of Nitrogen (NO, NO₂ and NO_x)

The sum of nitrogen dioxide (NO₂) and nitric oxide (NO) is known as oxides of nitrogen (NO_x). During high temperature combustion, atmospheric nitrogen (N₂) may combine with molecular oxygen (O₂) to form two molecules of NO and some NO₂. NO will readily react with ozone (O₃) in the atmosphere to form NO₂. NO₂ is a reddish-brown gas and is partially responsible for the "brown haze" observed over large cities. In Alberta, transportation is the major source of NO_x, elevated concentration are typically noted in urban centres and near roadways. Although the Poundmaker compound is within an urban centre and close to major roadways (less than 0.5 km from 184 St. and Anthony Henday Dr.), elevated NO concentration near the burn site may have contribution from the particle board fires. NO to NO₂ ratio can be used as an indication of air mass processing. That is to say, concentrations measured near a source will have higher NO to NO₂ ratio. Further downwind, where the air mass has undergone some level of processing and some NO has converted to NO₂ by reaction with O₃, the ratio will be lower.

Figures 9 and 10 present NO and NO₂ concentrations measured at the three MAML monitoring sites and Edmonton air quality monitoring stations. Alberta has an air quality objective for NO₂ of 0.212 ppm. This value was not exceeded. The maximum one-hour average NO₂ concentration at **Site 1** (outside the poundmaker compound) was 0.007 ppm. Further downwind, at **Site 2** and **3** the maximum one-hour concentrations were 0.004 and 0.006 ppm, respectively. NO₂ concentration at **Sites 1, 2 and 3** were comparable or lower than those measured at the three Edmonton air quality monitoring stations.

Closer to the burn site (**Site 1**) NO/NO₂ ratio was greater than unity (on average 1.33) indicating relatively fresh emissions. A maximum one-hour average NO concentration of 0.010 ppm was measured at **Site 1**, with peak one-minute concentration of 0.045 ppm. This concentration was measured between 07:00 and 08:00, prior to the start of the fire fighting exercise. The wind direction at the time was north-northwest. Elevated concentration at this time was likely due to the morning *rush-hour* traffic on Anthony Henday Dr. (Figure 1a). This being said, an increase in NO concentration concurrent to observation of smoke at a site was also noted. For example on August 31 (09:00-10:00) heavy smoke was noted at **Site 1**. One-hour average NO concentration at this time was 0.006 ppm, with peak one-minute concentration of

0.024 ppm. The maximum one-hour concentration for NO at **Site 2** and **3** were 0.003 and 0.002, respectively. In addition to being further downwind from the burn site, samples at **Site 2** and **3** were collected in the mid-morning and early afternoon hours, thus measurements would not have been influenced by *rush-hour* traffic emissions. Although some association between elevated smoke and NO_x (in particular NO) may be made, concentrations at this site are just as much influenced by nearby motor vehicle emissions.

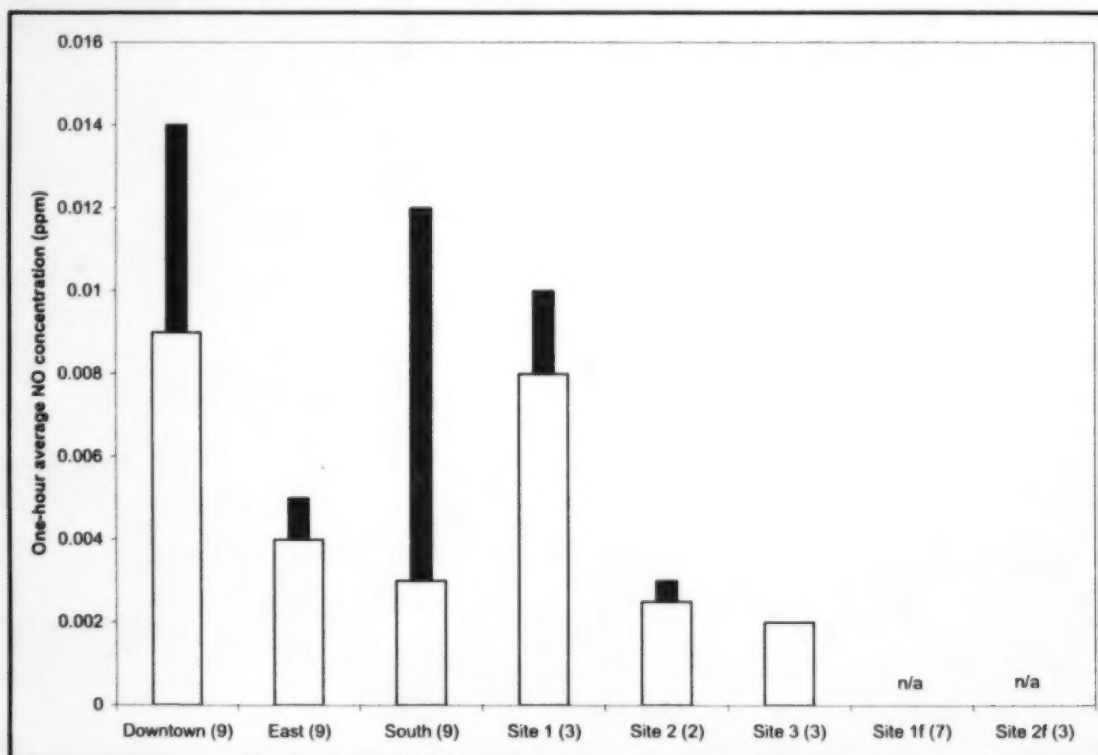


Figure 9: Median and maximum one-hour average concentrations for NO. Downtown, East and South indicate the three Edmonton air quality monitoring stations. A key for interpreting this figure is presented in Figure 2. The AMU is not equipped to monitor NO (Sites 1f and 2f).

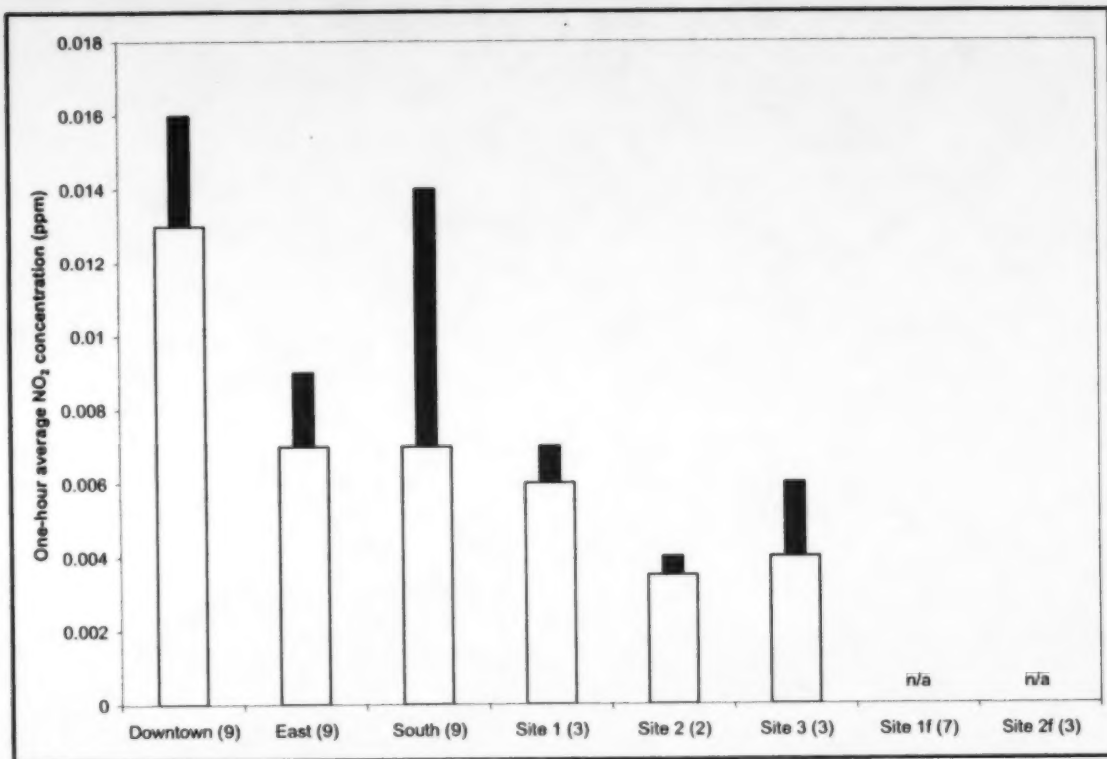


Figure 10: Median and maximum one-hour average concentration for NO_2 . Downtown, East and South indicate the three Edmonton air quality monitoring stations. A key for interpreting this figure is presented in Figure 2. The AMU is not equipped to monitor NO_2 (Site 1f and 2f).

3.4. Formaldehyde

Alberta has an ambient air quality objective for formaldehyde of 0.053 ppm.

Formaldehyde concentrations were measured using two sampling methods. Samples were collected using sorbent cartridges at five sites: four downwind sites and one background site. The background sample was collected for 3.5 hrs, while all other samples were collected for a period of one-hour. The longer collection time for the background sample provides sufficient sample for detection. In addition two SapphIRe analyzers were also used. One SapphIRe analyzed for formaldehyde concentrations on a shorter time scale about 30 m from the burn container. While a second SapphIRe analyzed for matches in the instruments library of compounds. A list of the compounds is found in Table A7. The instruments run during the morning of August 31 during which time there was at least one burn event that produced heavy smoke.

Laboratory analysis of the sorbent cartridges resulted in concentrations below the method detection limit for all the samples collected. The method detection limit (0.5 µg/sample) translates to 0.01 ppm ambient concentration for all but one sample⁶. These results illustrate that, even in close proximity to the burn container, the *one-hour average* formaldehyde concentrations⁷ were below 0.01 ppm.

Concentrations measured by the SapphIRe support the laboratory findings. For almost all the samples formaldehyde concentration was below the instruments detection limit. The exception was a period of 4 mins (09:28-09:32 on August 31) where an average concentration of 0.12 ppm was detected. The maximum one-minute average concentration at this time was 0.33 ppm. Heavy smoke was noted between 09:24 and 09:42, which corresponds to the time when formaldehyde was detected. This observation implies that although one-hour average concentrations were less than 0.01 ppm, higher concentrations maybe present for shorter sample intervals. The SapphIRe setup to detect multiple gases using the instruments library did not find a match that was above the minimum detection limit for this setting⁸.

⁶ One of the samples at the *poundmaker* compound had a lower sample flow thus 0.5mg/sample translates to 0.02 ppm ambient concentration.

⁷ The burn period lasted for approximately 20 minutes of the hour

⁸ Higher concentrations are required for detection when the SapphIRe is set to scan for the presence of multiple compounds.

Appendix A

Table A1: One-hour average concentrations for the various monitoring locations as measured by instruments on board the MAML

Sample Date	End Times	Site ¹	CO PPM	O ₃ PPM	THC PPM	CH ₄ PPM	RHC PPM	SO ₂ PPM	NO PPM	NO ₂ PPM	NO _x PPM	NH ₃ PPM	TRS PPM	H ₂ S PPM	PM ₁₀ µg/m ³	PM _{2.5} µg/m ³	PM ₁ µg/m ³	PAH ng/m ³
8/31/2007	07:09 to 08:09	Poundmaker site gate (Site 1)	0.3	0.011	1.9	1.9	bd	no data	0.010	0.007	0.015	0.001	bd	bd	13	9	6	11
8/31/2007	08:09 to 09:09	Poundmaker site gate (Site 1)	0.2	0.016	1.9	1.8	bd	no data	0.008	0.006	0.013	bd	bd	bd	18	7	4	11
8/31/2007	09:09 to 10:09	Poundmaker site gate (Site 1)	0.2	0.022	1.9	1.8	0.1	no data	0.006	0.005	0.010	bd	bd	bd	37	8	4	17
8/31/2007	10:21 to 11:21	104 Ave and 186 St (Site 2)	0.2	0.027	1.8	1.8	bd	no data	0.003	0.004	0.006	bd	bd	bd	36	8	5	3
8/31/2007	11:21 to 12:13	104 Ave and 186 St (Site 2)	0.1	0.031	1.8	1.8	bd	no data	0.002	0.003	0.004	bd	bd	bd	30	7	3	3
8/31/2007	12:16 to 13:16	104 ave and 184 St (Site 3)	0.1	0.034	1.8	1.8	bd	no data	0.002	0.006	0.007	bd	bd	bd	29	6	3	3
8/31/2007	13:16 to 14:16	104 ave and 184 St (Site 3)	0.1	0.038	1.8	1.8	bd	no data	0.002	0.004	0.005	bd	bd	bd	34	11	6	3
8/31/2007	14:16 to 15:16	104 ave and 184 St (Site 3)	0.1	0.042	1.8	1.8	bd	no data	0.002	0.003	0.004	bd	bd	bd	27	10	5	3

Table A2: Peak (one-minute) concentrations for the various monitoring locations as measured by instruments on board the MAML

Sample Date	End Times	Site ¹	CO PPM	O ₃ PPM	THC PPM	CH ₄ PPM	RHC PPM	SO ₂ PPM	NO PPM	NO ₂ PPM	NO _x PPM	NH ₃ PPM	TRS PPM	H ₂ S PPM	PM ₁₀ µg/m ³	PM _{2.5} µg/m ³	PM ₁ µg/m ³	PAH ng/m ³
8/31/2007	07:09 to 08:09	Poundmaker site gate (Site 1)	0.7	0.014	2.2	2.1	0.2	no data	0.045	0.035	0.057	0.030	bd	bd	61	57	51	41
8/31/2007	08:09 to 09:09	Poundmaker site gate (Site 1)	0.3	0.022	2.0	1.9	0.1	no data	0.045	0.014	0.041	bd	bd	bd	78	14	5	39
8/31/2007	09:09 to 10:09	Poundmaker site gate (Site 1)	0.7	0.027	2.1	1.9	0.3	no data	0.024	0.016	0.029	bd	bd	bd	142	18	7	457
8/31/2007	10:21 to 11:21	104 Ave and 186 St (Site 2)	0.4	0.030	1.9	1.9	0.1	no data	0.015	0.008	0.016	bd	bd	bd	65	18	15	10
8/31/2007	11:21 to 12:13	104 Ave and 186 St (Site 2)	0.2	0.034	1.9	1.9	0.1	no data	0.003	0.004	0.006	bd	bd	bd	45	13	10	7
8/31/2007	12:16 to 13:16	104 ave and 184 St (Site 3)	0.4	0.038	2.1	1.9	0.1	no data	0.008	0.062	0.065	bd	bd	bd	64	30	27	43
8/31/2007	13:16 to 14:16	104 ave and 184 St (Site 3)	0.3	0.042	2.0	1.9	0.1	no data	0.012	0.007	0.013	bd	bd	bd	124	84	39	11
8/31/2007	14:16 to 15:16	104 ave and 184 St (Site 3)	0.3	0.047	2.0	2.0	0.1	no data	0.014	0.007	0.009	bd	bd	bd	138	102	60	21

Notes:

1- Refer to Section 2 for a detailed site description

ppm – parts per million µg/m³ – micrograms per meter cubed ng/m³ – nanograms per meter cubed

bd – below detection limit

Table A3: Meteorological conditions and MAML operator's comments

Sample Date	End Times	Site ¹	Temp Deg C	RH %	WSP KPH	WDR	Operator's comments
8/31/2007	07:09 to 08:09	Poundmaker site gate (Site 1)	15.0	88.5	9.1	WNW	
8/31/2007	08:09 to 09:09	Poundmaker site gate (Site 1)	16.1	82.8	10.4	WNW	no test burn, only light smouldering
8/31/2007	09:09 to 10:09	Poundmaker site gate (Site 1)	17.8	73.0	9.1	W	heavy smoke 9:24 to 9:42, smoke drifting across in front of MAML
8/31/2007	10:21 to 11:21	104 Ave and 186 St (Site 2)	20.4	63.3	8.3	W	Smoke 10:44 to 11:12 MAML positioned downwind
8/31/2007	11:21 to 12:13	104 Ave and 186 St (Site 2)	20.4	63.3	13.9	NW	
8/31/2007	12:16 to 13:16	104 ave and 184 St (Site 3)	21.2	56.4	8.9	WNW	
8/31/2007	13:16 to 14:16	104 ave and 184 St (Site 3)	22.4	48.5	9.4	WNW	Smoke from 13:15 to 13:30 MAML positioned downwind
8/31/2007	14:16 to 15:16	104 ave and 184 St (Site 3)	23.1	43.4	11.6	WNW	Last Burn

Notes:

1- Refer to Section 2 for a detailed site description

Temp ° C- Temperature in degrees centigrade RH % – Relative humidity in percentage

WSP KPH – Wind speed in Km/hr WDR – Wind direction

Table A4: One-hour average particulate matter concentrations for the various monitoring locations as measured by instruments on board the AMU

Sample Date	End Times	Site ¹	PM ₁₀ μg/m ³	PM _{2.5} μg/m ³	PM ₁ μg/m ³
8/27/2007	08:00 to 08:59	30 m downwind of burn (Site 1f)	15	11	9
8/27/2007	09:00 to 09:59	30 m downwind of burn (Site 1f)	117	105	55
8/27/2007	11:00 to 11:59	104 ave downwind of burn (Site 2f)	37	31	15
8/31/2007	08:00 to 08:59	30 m downwind of burn (Site 1f)	24	13	6
8/31/2007	09:00 to 09:59	30 m downwind of burn (Site 1f)	318*	296*	239*
8/31/2007	10:00 to 10:59	30 m downwind of burn (Site 1f)	96	60	29
8/31/2007	11:00 to 11:59	30 m downwind of burn (Site 1f)	43	17	3
8/31/2007	12:00 to 12:59	104 ave downwind of burn (Site 2f)	26	11	2
8/31/2007	13:00 to 13:59	104 ave downwind of burn (Site 2f)	79	41	11
8/31/2007	14:30 to 15:29	30 m downwind of burn (Site 1f)	284*	261*	181

Table A5: Peak (one-minute) particulate matter concentrations for the various monitoring locations as measured by instruments on board the AMU

Sample Date	End Times	Site ¹	PM ₁₀ μg/m ³	PM _{2.5} μg/m ³	PM ₁ μg/m ³
8/27/2007	08:00 to 08:59	30 m downwind of burn (Site 1f)	45	39	38
8/27/2007	09:00 to 09:59	30 m downwind of burn (Site 1f)	995	959	310
8/27/2007	11:00 to 11:59	104 ave downwind of burn (Site 2f)	269	234	108
8/31/2007	08:00 to 08:59	30 m downwind of burn (Site 1f)	96	43	18
8/31/2007	09:00 to 09:59	30 m downwind of burn (Site 1f)	> 999	> 999	> 999
8/31/2007	10:00 to 10:59	30 m downwind of burn (Site 1f)	989	984	647
8/31/2007	11:00 to 11:59	30 m downwind of burn (Site 1f)	166	57	7
8/31/2007	12:00 to 12:59	104 ave downwind of burn (Site 2f)	41	18	8
8/31/2007	13:00 to 13:59	104 ave downwind of burn (Site 2f)	903	369	80
8/31/2007	14:30 to 15:29	30 m downwind of burn (Site 1f)	> 999	> 999	979

Notes:

1- Refer Section 2 for a detailed site description

*- One hour average concentrations likely under estimates concentration for that hour, sample period includes times when particle concentrations exceeded instrument upper detection limit.

> 999 particle concentrations were above instrument upper detection limit.

ppm – parts per million μg/m³ – micrograms per meter cubed ng/m³ – nanograms per meter cubed

bd – below detection limit

Table A6: One-hour average concentrations at the three air quality monitoring stations in Edmonton

Station	DATE	End time	CO ppm	THC ppm	NO ppm	NO ₂ ppm	O ₃ ppm	SO ₂ ppm	H ₂ S ppm	PM ₁₀ µg/m ³	PM _{2.5} µg/m ³
Edmonton Central	31-Aug-07	8:00	0.4	1.8	0.013	0.014	0.007	n/a	n/a	n/a	3
Edmonton Central	31-Aug-07	9:00	0.3	1.8	0.008	0.013	0.013	n/a	n/a	n/a	2
Edmonton Central	31-Aug-07	10:00	0.3	1.7	0.007	0.010	0.016	n/a	n/a	n/a	3
Edmonton Central	31-Aug-07	11:00	0.3	1.8	0.009	0.011	0.019	n/a	n/a	n/a	1
Edmonton Central	31-Aug-07	12:00	0.3	1.8	0.008	0.012	0.020	n/a	n/a	n/a	4
Edmonton Central	31-Aug-07	13:00	0.4	1.7	n/a	n/a	0.019	n/a	n/a	n/a	4
Edmonton Central	31-Aug-07	14:00	0.3	2.2	n/a	n/a	0.021	n/a	n/a	n/a	3
Edmonton Central	31-Aug-07	15:00	0.3	1.7	0.012	0.014	0.022	n/a	n/a	n/a	1
Edmonton Central	31-Aug-07	16:00	0.4	1.7	0.014	0.016	0.021	n/a	n/a	n/a	1
Edmonton Central	Median		0.3	1.8	0.009	0.013	0.019	n/a	n/a	n/a	3
Edmonton East	31-Aug-07	8:00	0.1	2	0.005	0.009	0.014	bd	bd	n/a	3
Edmonton East	31-Aug-07	9:00	0.1	1.9	0.005	0.008	0.016	bd	bd	n/a	3
Edmonton East	31-Aug-07	10:00	0.1	2	0.005	0.007	0.022	bd	bd	n/a	1
Edmonton East	31-Aug-07	11:00	0.1	1.9	0.003	0.006	0.025	bd	bd	n/a	1
Edmonton East	31-Aug-07	12:00	0.1	1.9	0.004	0.006	0.028	bd	bd	n/a	3
Edmonton East	31-Aug-07	13:00	0.1	1.9	0.003	0.005	0.030	bd	bd	n/a	2
Edmonton East	31-Aug-07	14:00	0.1	1.9	0.004	0.007	0.029	bd	bd	n/a	3
Edmonton East	31-Aug-07	15:00	0.1	1.9	0.005	0.008	0.030	bd	bd	n/a	2
Edmonton East	31-Aug-07	16:00	0.1	2.3	0.003	0.007	0.033	bd	bd	n/a	1
Edmonton East	Median		0.1	1.9	0.004	0.007	0.028	bd	bd	n/a	2
Edmonton South	31-Aug-07	8:00	0.1	1.9	0.006	0.009	0.012	bd	n/a	20	5
Edmonton South	31-Aug-07	9:00	0.1	2.0	0.012	0.014	0.010	0.001	n/a	28	10
Edmonton South	31-Aug-07	10:00	0.1	1.9	0.005	0.009	0.019	0.001	n/a	22	7
Edmonton South	31-Aug-07	11:00	0.1	1.8	0.003	0.006	0.026	bd	n/a	19	5
Edmonton South	31-Aug-07	12:00	0.1	1.8	0.003	0.007	0.027	0.001	n/a	45	9
Edmonton South	31-Aug-07	13:00	0.1	1.8	0.003	0.007	0.027	0.001	n/a	46	14
Edmonton South	31-Aug-07	14:00	0.1	1.8	0.004	0.007	0.029	0.001	n/a	31	7
Edmonton South	31-Aug-07	15:00	0.1	1.8	0.002	0.005	0.035	bd	n/a	27	5
Edmonton South	31-Aug-07	16:00	0.1	1.8	0.001	0.004	0.037	bd	n/a	21	5
Edmonton South	Median		0.1	1.8	0.003	0.007	0.027	0.001	n/a	27	7

Notes:

ppm – parts per million µg/m³ – micrograms per meter cubed ng/m³ – nanograms per meter cubed
 bd – below detection limit n/a- parameter not monitored

Table A7: List of compounds in the SupplRe's Library

1,1,2,2-Tetrachloroethane	Dichloroethylether	Methylene Chloride
1,1,2-Trichloroethane	Dichloropentafluoropropane	MIBK
1,1-Dichloro-1-Fluoroethane	Dichlorotrifluoroethane	Nitrogen Trifluoride
1,1-Dichloroethane	Diethyl Ether	Nitrous Oxide
1,2-Dichloroethene, trans-	Diethylamine	Octane
1,2-Dichloroethylene, cis-	Dimethylacetamide	Pentane
1,3-Butadiene	Dioxane	PGMEA
Acetaldehyde	DPGME	Phosgene
Acetic Acid	Enflurane	Propane
Acetone	Ethane	Propanol, n-
Acetonitrile	Ethyl Acetate	Propylene Oxide
Acetophenone	Ethyl Alcohol	Pyridine
Acetylene	Ethyl Benzene	R-113
Acrylonitrile	Ethyl Chloride	R-114
Ammonia	Ethyl Lactate	R-12
Aniline	Ethylene	R-124
Benzaldehyde	ETO	R-134A
Benzene	Formaldehyde	R-13B1
Butane	Formic Acid	R-143A
Butanol, n-	Halothane	R-152A
Butyl Acetate	Heptane	R-21
Butyl Cellosolve	Hexanes	R-22
Butyl Methyl Ether, t-	Hydrazine	Sevoflurane
Carbon Dioxide	Isobutane	SF6
Carbon Disulfide	Isoflurane	Styrene
Carbon Tetrachloride	Isopropyl Alcohol	Sulfur Dioxide
Cellosolve	Isopropyl Ether	Sulfuryl Flouride
Cellosolve Acetate	m-Cresol	t-Butyl Alcohol
Chlorobenzene	Methane	Tetrachloroethylene
Chlorobromomethane	Methyl Acetate	Tetrahydrofuran
Chloroform	Methyl Acrylate	Toluene
CO	Methyl Alcohol	Trichloroethylene
Cumene	Methyl Amine	Trichlorofluoromethane
Cyclohexane	Methyl Cellosolve	Vinyl Acetate
Cyclopentane	Methyl Cellosolve	Vinyl Chloride
Desflurane	Methyl Chloride	Vinylidene Chloride
Dichlorobenzene, m-	Methyl Chloroform	Xylenes
Dichlorobenzene, o-	Methyl Ethyl Ketone	
Dichlorobenzene, p-	Methyl Methacrylate	

Appendix B

The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives¹ are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta. The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table B1.

Table B1: Alberta's Ambient Air Quality Objective measured by the MAML

Pollutant	One-hour AAAQO (ppm)	Basis for Objective
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function

ppm - parts per billion

¹ Alberta Ambient Air Quality Objectives. Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table B2 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.



Figure B1: Alberta Environment's Mobile Air Monitoring Laboratory

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia (NH_3)	0.001 ppm	5 ppm
Ozone (O_3)	0.001 ppm	0.5 ppm
Carbon Monoxide (CO)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (CH_4)	0.1 ppm	20 ppm
Reactive Hydrocarbons (RHC)	0.1 ppm	20 ppm
Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Oxides of nitrogen		
Nitrogen dioxide (NO_2)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO_x)	0.0006 ppm	1 ppm
Particulate Matter		
Particulate Matter $<10\mu\text{m}$ (PM_{10})	1 $\mu\text{g}/\text{m}^3$	1.0 g/m^3
Particulate Matter $<2.5\mu\text{m}$ ($\text{PM}_{2.5}$)	1 $\mu\text{g}/\text{m}^3$	1.0 g/m^3
Particulate Matter $<1\mu\text{m}$ (PM_1)	1 $\mu\text{g}/\text{m}^3$	1.0 g/m^3
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m^3	1000 ng/m^3
Sulphur Compounds		
Hydrogen Sulphide (H_2S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO_2)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm = parts per million

 ng/m^3 = nanograms per cubic meter $\mu\text{g}/\text{m}^3$ = micrograms per cubic meter g/m^3 = grams per cubic meter

* The **lower detection limit** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The **upper detection limit** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia (NH ₃)	0.001 ppm	5 ppm
Ozone (O ₃)	0.001 ppm	0.5 ppm
Carbon Monoxide (CO)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (CH ₄)	0.1 ppm	20 ppm
Reactive Hydrocarbons (RHC)	0.1 ppm	20 ppm
Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Oxides of nitrogen		
Nitrogen dioxide (NO ₂)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO _x)	0.0006 ppm	1 ppm
Particulate Matter		
Particulate Matter <10µm (PM ₁₀)	1 µg/m ³	1.0 g/m ³
Particulate Matter <2.5µm (PM _{2.5})	1 µg/m ³	1.0 g/m ³
Particulate Matter <1µm (PM ₁)	1 µg/m ³	1.0 g/m ³
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m ³	1000 ng/m ³
Sulphur Compounds		
Hydrogen Sulphide (H ₂ S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO ₂)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm = parts per million

ng/m³ = nanograms per cubic meterµg/m³ = micrograms per cubic meterg/m³ = grams per cubic meter

* The **lower detection limit** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The **upper detection limit** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

